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NOTES AND OBSERVATIONS.

1. DETAIL ILLUSTRATIONS OF YUCCA.

During the time that I have resided in St. Louis, I have many times had occasion to observe the principal facts connected with the pollination of *Yucca filamentosa* and the forms referred to that species by Dr. Engelmann, and to demonstrate them to visitors to the Garden. The Chairman of the Garden Committee of the institution, who viewed them in my company last spring, was so impressed with their interest that I made a short visit to the Rocky Mountains early in July last, for the purpose of making similar observations on *Y. angustifolia*, with the intention of summarizing for the present volume all that was known on the subject. On my return I found on my table a letter from Professor Riley, to whom, and Dr. Engelmann, the discovery and elaboration of the curious facts is due, offering to prepare for this report a paper such as I had in mind. As an account from his pen promised far greater completeness and interest than I could have hoped to attain, his offer was very gratefully accepted, and the article appears in the preceding pages.

While reviewing the material at the Garden bearing upon *Yucca*, I found a large number of drawings by Dr. Engelmann, which I had intended utilizing in connection with my paper; and as these sketches depict the floral and capsular structure of some species that have as yet been inadequately figured, I have had them redrawn in ink by Miss Grace E. Johnson for photo-engraving, and publish them herewith. I have included with them reproductions of photographs showing the habit of growth of several species, and also some figures illustrative of our observations on *Y. filamentosa*, which had been prepared before the receipt of Professor Riley's paper, and may prove of interest in connection with it.

Yucca is a small genus of evergreen leaved plants of the lily family, belonging to the Central American flora and that of the Southern United States, one species reaching well up into the Rocky Mountains. Engelmann recognized fourteen species, while Baker, who has also made the *Yuccas* the subject of much study, admits half as many more, several of the additional species having been called varieties by Engelmann, though several others are known only from plants in cultivation (few of which have flowered or fruited), and are regarded by some botanists as probable forms or derivatives of other species known in a state of nature.

While the more eastern of our species are short-stemmed, several of those native in the southwest become trees, often of considerable size and with thick rough bark. The fruit of the section with pulpy carpels is more or less eaten, and the fibers of the leaves are used for cordage by the Mexicans who also make a good deal of domestic use of the root-stocks as a substitute for soap. Some years since the proprietors of an English newspaper established a mill in the home of one of the tree *Yuccas*, intending to make paper pulp from its wood, but the enterprise was shortly abandoned.

Like most of the monocotyledons, aside from the palms, *Yucca* has left few if any fossil remains complete enough for certain determination, and Professor Lester F. Ward informs me that only one fossil species has ever been referred to the genus *Yucca*, — namely *Y. Roberti*, Bureau, found in the Paris basin, — and that even this is generally considered to belong to *Yuccites*, a form assemblage, some of the components of which are of very early origin, but none of them of necessity closely allied to the existing genus *Yucca*, nor representing its ancestral type.

The principal revisions of the genus are by Engelmann, in the Transactions of the St. Louis Academy, iii, pp. 17, 210 and 371 (brought together, with additional descriptions and notes printed elsewhere by him, in his Collected Writ-

ings, p. 276, — published under the auspices of the Garden in 1877); Baker, in the Journal of the Linnean Society, xviii, p. 219, and Kew Bulletin of Miscellaneous Information, Jan. 1892, p. 7; and Watson, in the Proceedings of the American Academy, xiv, p. 251. Reference should be made to these papers, and to Professor Sargent's Forest Trees of North America, p. 218, for the synonymy and bibliography of each species, since only the more recent figures are referred to here. The retention of varietal names for forms subsequently raised to specific rank would involve certain changes in the nomenclature, which are indicated under the species affected.

No better general classification of the *Yuccas* that are actually known has been found than the following, which represents Engelmann's views, except that by general consent *Y. filifera* has been raised to specific rank from a variety of *Y. baccata*, where Engelmann left it, while Mr. Brandegee has added *Y. valida*, from Mexico, and Baker has just added from the gardens of the Riviera *Y. Hamburii*, said to be from Rocky Mountain seed.

From an examination of this enumeration of species, in connection with the accompanying plates and the figures cited, it will be seen that we are still unpossessed of a knowledge of the floral and fruit details of several species, while some of the figures drawn from dried specimens may be inaccurate in some degree; so that persons who have it in their power to secure faithful photographs or drawings from growing plants may materially contribute to a correct knowledge of this difficult group by supplying the deficiencies, and they may further the same end by obtaining ripe seeds for cultivation in botanical gardens.

SYNOPTICAL LIST.

- * **EUYUCCA.** — Styles stout, the connivent apexes forming a more or less developed central stigmatic cavity: filaments papillate.
- A. **Sarcoyucca.** — Fruit pendent, fleshy and indehiscent: ovules and seeds thick, marginless: albumen ruminated.

Y. aloifolia, L. Sp. i. (1753), 319; Engelm. Coll. Writings, 287; Watson, *l. c.* 251; Baker, *l. c.* 221; Nicholson Gard. Dict. 228. — Plates 7 & 44.

Y. Yucatanica, Engelm. Trans. St. L. Acad. iii. (1873), 37, and reprint 288; Watson, *l. c.* 251; Baker, *l. c.* 221. —Plate 45.

Y. Guatemalensis, Baker, Refugium Botanicum, v. (1872), pl. 313, and Journ. Linn. Soc. *l. c.* 222; Engelmann, *l. c.* 289; Watson, *l. c.* 251; Nicholson, *l. c.* 233.

Y. Schottii, Engelm. Trans. St. L. Acad. iii. (1873), 46, and *l. c.* 292, 300; Watson, *l. c.* 252; Baker, *l. c.* 228.

Y. macrocarpa, Engelm. Bot. Gaz. vi. (1881), 224, and *l. c.* 299 and 300; Nicholson, *l. c.* 234; Baker, Kew Bull. 1892, 8. —Plate 46. (Perhaps only the well developed form of the preceding).

Y. valida, Brandege, Proc. Calif. Acad. (2), ii. (1889), 208, plate 11; abst. in Garden & Forest, iii. 106.

Y. Treculeana, Carr. Rev. Hort. vii. (1858), 280; Engelm. *l. c.* 290; Watson, *l. c.* 252; Baker, *l. c.* 226; Sargent, *l. c.* 218, and Garden & Forest, i. 54 (with figure of habit); Pringle, Garden & Forest, iii. 338; Nicholson, *l. c.* 234, f. 250. —Plates 1 & 47.

Y. baccata, Torr. Bot. Mex. Bound. (1858), 221; Engelm. *l. c.* 276, 291, 300; Watson, *l. c.* 252; Baker, *l. c.* 229; Parish, Garden & Forest, iv. 136; Nicholson, *l. c.* 229. —Plates 2 & 48.

Y. filifera, Chabaud, Rev. Hort. 1876, 432; Nicholson, *l. c.* 232, fig. 243, 244; Sargent, Gard. & Forest, i. 78 (with habit figures), and iv. 324 and 396; Baker, Bot. Mag. (3), xlvii. pl. 7197. — *Y. baccata*, var. *australis*, Engelm. Trans. St. L. Acad. iii. (1873), 44, and *l. c.* 291; Watson, *l. c.* 252; Baker, *l. c.* 229. — An adoption of the varietal name, which has priority, would cause the plant to be known as *Y. australis* (Engelm.). —Plates 3 & 4.

(*Y. Desmetiana*, Baker, Gard. Chron. 1870, 1217, Journ. Linn. Soc. *l. c.* 222, and Kew Bull. 1892, 8, Engelmann, *l. c.* 290; and *Y. Peacockii*, Baker, *l. c.* 223, and Kew Bull.

l. c. 8, are species unknown in flower, but perhaps belonging to the group *Sarcocyucca*.)

B. *Clistoyucca*.—Fruit pendent (or erect in the first), dry and coriaceous but indehiscent: ovules and seeds thinner, marginless: albumen entire.

Y. brevifolia, Engelm. Bot. King (1871), 496; *l. c.* 276, 293, 297, 298; Watson, *l. c.* 252; Baker, *l. c.* 221; Sargent, *l. c.* 218; Parish, Gard. & Forest, iv. 135. — *Y. Draconis*,? var. *arborescens*, Torr. Botany of Whipple in Rept. Pac. R. R. Surv. iv. (1857), 147. — If the varietal name were adopted, this would be *Y. arborescens* (Torr.) — Plates 5 & 49.

Y. gloriosa, L. Sp. i. (1753), 319; Engelm. *l. c.* 289, 297; Watson, *l. c.* 251; Baker, *l. c.* 225; Nicholson, *l. c.* 232, f. 247–249. — Plates 6, 7 & 50.

C. *Chenoyucca*.—Fruit erect, capsular with septicidal dehiscence: ovules and seeds thin, the latter broadly wing-margined: albumen entire.

Y. rupicola, Scheele, Linnæa, xxiii. (1850), 143; Engelm. *l. c.* 293; Watson, *l. c.* 253; Baker, *l. c.* 222, and Bot. Mag. (3), xlvii. pl. 7172; Nicholson, *l. c.* 234. — Plate 51.

Y. angustifolia, Pursh, Fl. (1814), 227; Engelm. *l. c.* 276, 294; Watson, *l. c.* 253; Baker *l. c.* 226; Sargent, Gard. & For. ii. 244, 247 (habit figures); Nicholson, *l. c.* 228, f. 238 & 239. — Plates 8 & 51.

Y. elata, Engelm. Bot. Gaz. vii. (1882), 17; *l. c.* 299; Sargent, *l. c.* 219, and Gard. & For. ii. 368 (with habit figures). — *Y. angustifolia*, var. *elata*, Engelm. Proc. St. L. Acad. iii. (1873), 50; *l. c.* 294. — *Y. angustifolia*, var. *radiosa*, Engelm. Bot. King (1871), 496. — The rule of priority, if applied to varietal names, would make this *Y. radiosa* (Engelm.) — Plate 9.

Y. filamentosa, L. Sp. i. (1753), 319; Engelm. *l. c.* 295; Watson, *l. c.* 254; Baker, *l. c.* 227; Nicholson, *l. c.* 231, f. 240–242. — Plates 10, 52 & 53.

(*Y. Hanburii*, Baker, Kew Bull. 1892, 8, from the de-

scription of foliage characters would appear to belong to the group *Chænoyucca*, but its flower and fruit are unknown.)

* * *HESPEROYUCCA*.—Style slender, with an expanded peltate or thimble shaped stigma: filaments glabrous.

Y. Whipplei, Torr. Bot. Mex. Bound. (1859), 222; Engelm. *l. c.* 277, 296, 297, 298; Watson, *l. c.* 254; Baker, *l. c.* 230; *Revue Horticole*, 1884, 324; Nicholson, *l. c.* 234. — Plates 11, 12 & 54. — Baker, in *Kew Bulletin*, January 1892, 8, proposes to separate this from *Yucca*, under the generic name *Hesperoyucca*.

EXPLANATION OF PLATES ILLUSTRATIVE OF *YUCCA*.

Plate 1. *Y. Treculeana*.—Plant blooming at the Villa Thuret, Antibes, France, in 1876.

Plate 2. *Y. baccata*.—From a photograph taken near San Diego, Cal., Mar. 16, 1876, by Parker, $\times \frac{1}{30}$.

Plate 3. *Y. filifera*.—Young plants cultivated at the Villa Thuret, Antibes, France, in 1876.

Plate 4. *Y. filifera*.—Plants blooming at the Villa Thuret in 1891, from a photograph furnished by Professor Naudin.

Plate 5. *Y. brevifolia*.—Plant in the desert east of the Sierra Nevada, $\times \frac{1}{60}$; from photograph presented by Dr. Parry in 1867.

Plate 6. *Y. gloriosa*.—Specimen blooming at the Villa Thuret, Antibes, France, in 1876. (The original of a cut published in the *Gardeners' Chronicle*, June 30, 1883.)

Plate 7. *a. Y. aloifolia*; *b. Y. gloriosa*.—From a photograph of fruiting plants taken in 1872, on the grounds of the Department of Agriculture, $\times \frac{1}{17}$.

Plate 8. *Y. angustifolia*.—Fruiting plants on the mountains near Manitou, Col., July, 1891.

Plate 9. *Y. elata*.—Flowering specimen on the plains of Arizona, photographed by Pringle. Copied, by permission, from *Garden & Forest*, ii. 569.

Plate 10. *Y. filamentosa*. — Plants blooming in the Missouri Botanical Garden, June, 1891.

Plate 11. *Y. Whipplei*. — Plants beginning to bloom, $\times \frac{1}{25}$, from a photograph by Parker, Apr. 13, 1876, near San Diego, Cal.

Plate 12. *Y. Whipplei*. — Plants in full bloom, $\times \frac{1}{25}$, from a photograph taken near San Luis Obispo, Cal., in 1873, by Dr. W. W. Hays.

Plate 44. *Y. aloifolia*. — 1. Stamen and pistil, $\times 2$; 2, ends, and 3, side view and section, of fruit, natural size; 4, sections of seed, $\times 2$. — After Engelmann.

Plate 45. *Y. Yucatana*. — 1, Habit, after a sketch by Schott in 1865; 2 and 3, flowers, natural size; 4, stamens and pistil, $\times 2$; 5, leaf margin, $\times 15$. — After Engelmann.

Plate 46. *Y. macrocarpa*. — Two fruits, natural size. — After Engelmann.

Plate 47. *Y. Treculeana*. — 1, Flower, natural size; 2, stigma, $\times 2$; 3, fruit, and 4, cross section of same, natural size; 5, sections of seed, $\times 2$. — After Engelmann.

Plate 48. *Y. baccata*. — 1, Stamen and pistil, natural size, and cross section of ovary, $\times 2$; 2, fruit, natural size; 3, sections of same, reduced one-half; 4, sections of seed, $\times 2$. — After Engelmann.

Plate 49. *Y. brevifolia*. — 1, Margin of leaf, $\times 15$; 2, pistil, natural size; 3, stamens, $\times 5$; 4, fruit, and 5, end view of same, natural size; 6, sections of seed, $\times 2$. — After Engelmann.

Plate 50. *Y. gloriosa*. — 1, Flower, natural size; 2, pistil and cross sections of same, $\times 2$; 3, fruit, and section of same, natural size (from photographs of the Washington fruit of plate 7, *b*); 4, sections of seed, $\times 2$. — After Engelmann.

Plate 51. 1-4, *Y. rupicola*; 5-7, *Y. angustifolia*. — 1, Symmetrical capsules, natural size; 2, section of seed, $\times 2$; 3, margin of leaf of var. *rigida*, $\times 15$, and 4, prominence of same, $\times 75$. — 5, Stamens and pistil, natural size;

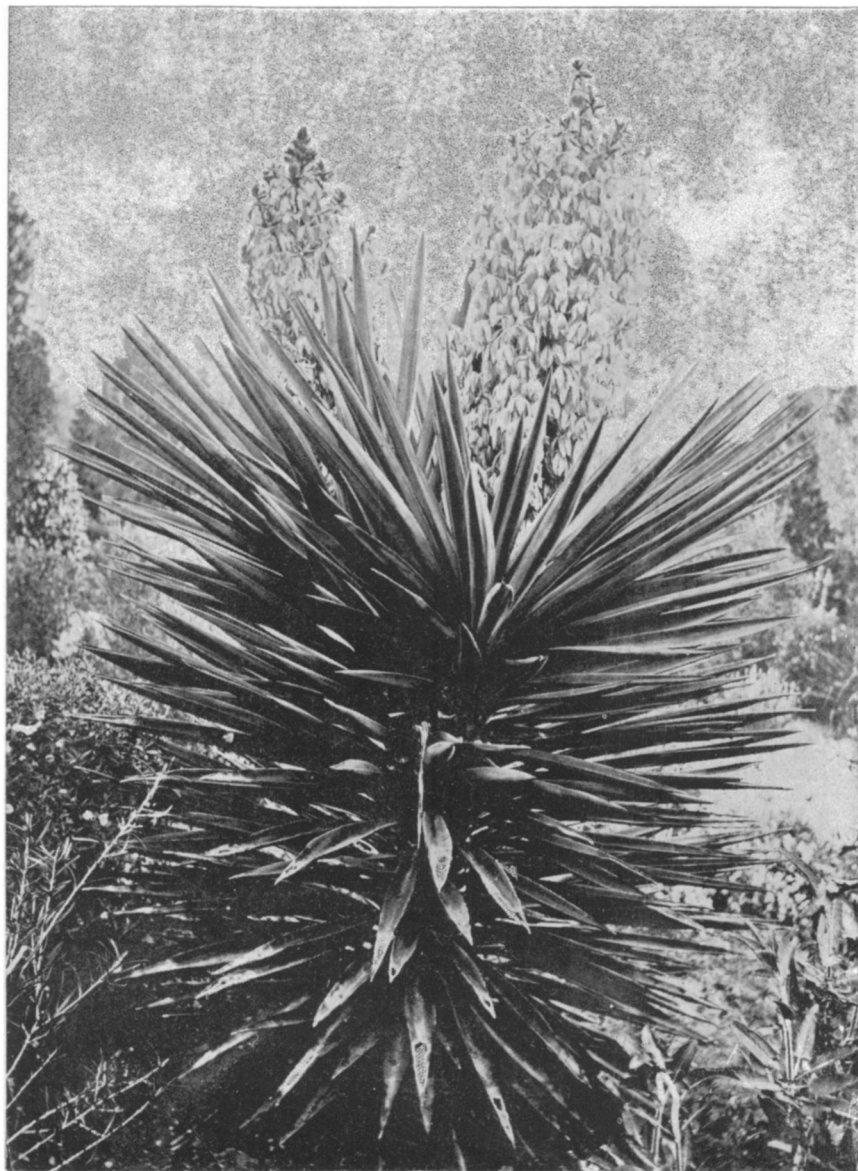
6, symmetrical capsule, natural size; 7, sections of seed, $\times 2$. — After Engelmann.

Plate 52. *Y. filamentosa*. — 1, Sections of pistil at various heights, showing connection of stigmatic chamber with ovarian cells, $\times 2$; 2, stigma, $\times 3$; 3, stamen before and after dehiscence, enlarged; 4, Pronuba larva *in situ* in nearly mature capsule, natural size; 5, young ovules bored by larva, enlarged; 6, capsule (too symmetrical) after escape of larvæ, natural size; 7, seed and sections, $\times 2$; 8, developing egg of Pronuba, $\times 30$. — 1 and 5 to 8, after Engelmann; the remainder from nature by Miss Johnson.

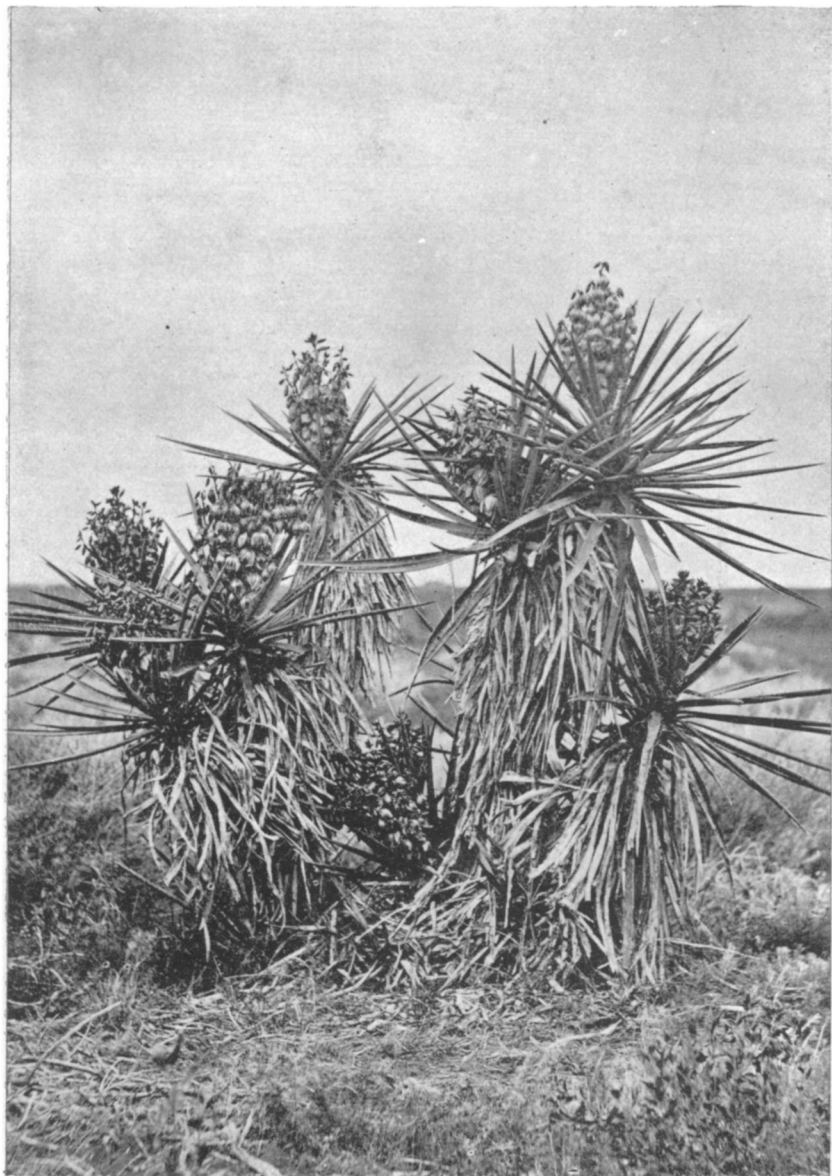
Plate 53. *Y. filamentosa*. — 1, Pistil at time of fertilization, in longitudinal section, showing on the right development of pollen tubes through the stylar channel into ovary, and on the left the septal nectar gland A, with its duct, B, and outlet C, $\times 5$; 2, part of cross section at A B, showing below, the outer portion of septal gland, and above, the duct B and its outward closure by the surface papillæ of ovary, $\times 75$; 3, pollen tube, $\times 150$; 4, emergence of same from extine of pollen grain, and 5, distal end of same, showing the not infrequent occlusion of cell cavity, both $\times 400$; 6, apex of ovule in longitudinal section, showing egg apparatus and entering pollen tube, $\times 400$. — 3 and 4 after Engelmann, the remainder from nature by Mr. Webber.

Plate 54. *Y. Whipplei*. — 1, Section of flower, and 2, side view of pistil, — from the Gardeners' Chronicle; 3, pistil, 4, section of stigma, 5, section of ovary, and 6, stamen, enlarged; 7, capsule, natural size; 8, sections of seed, $\times 2$. — After Engelmann.

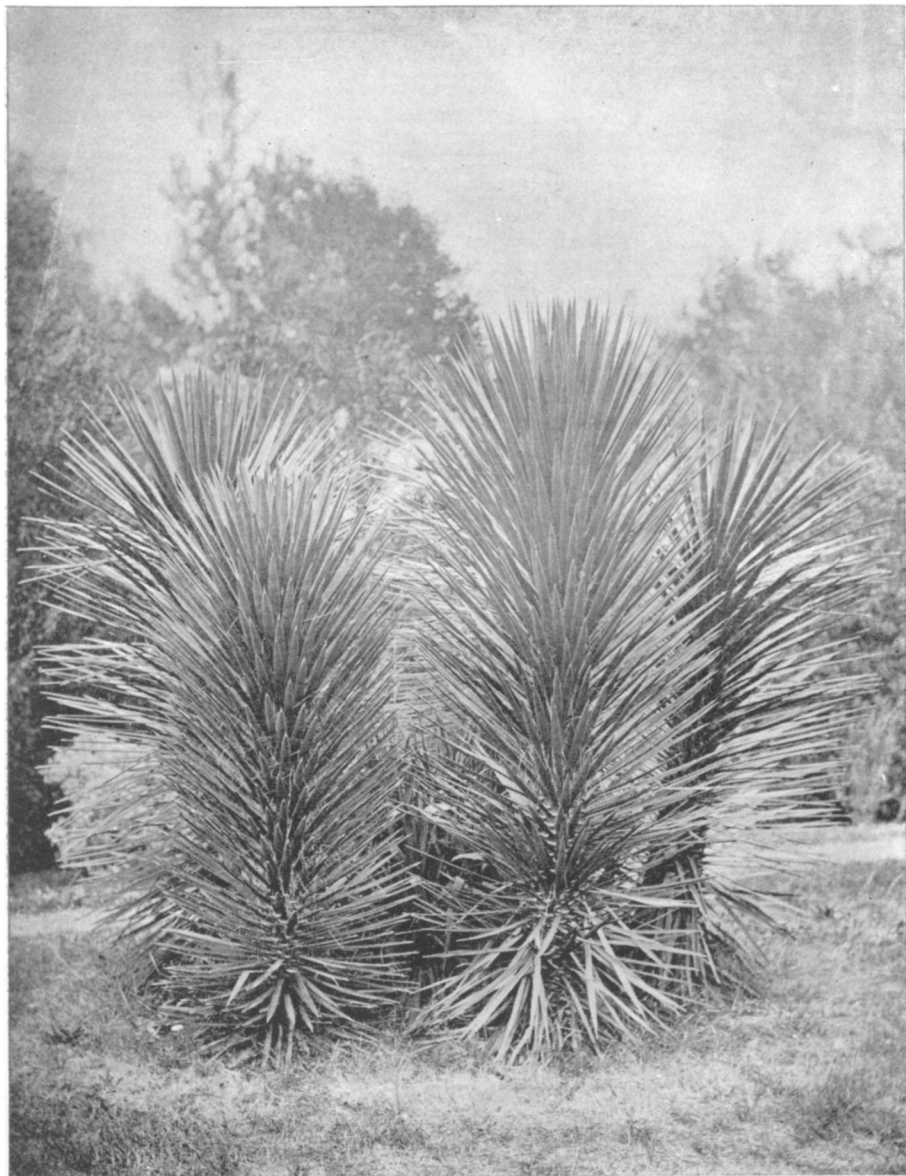
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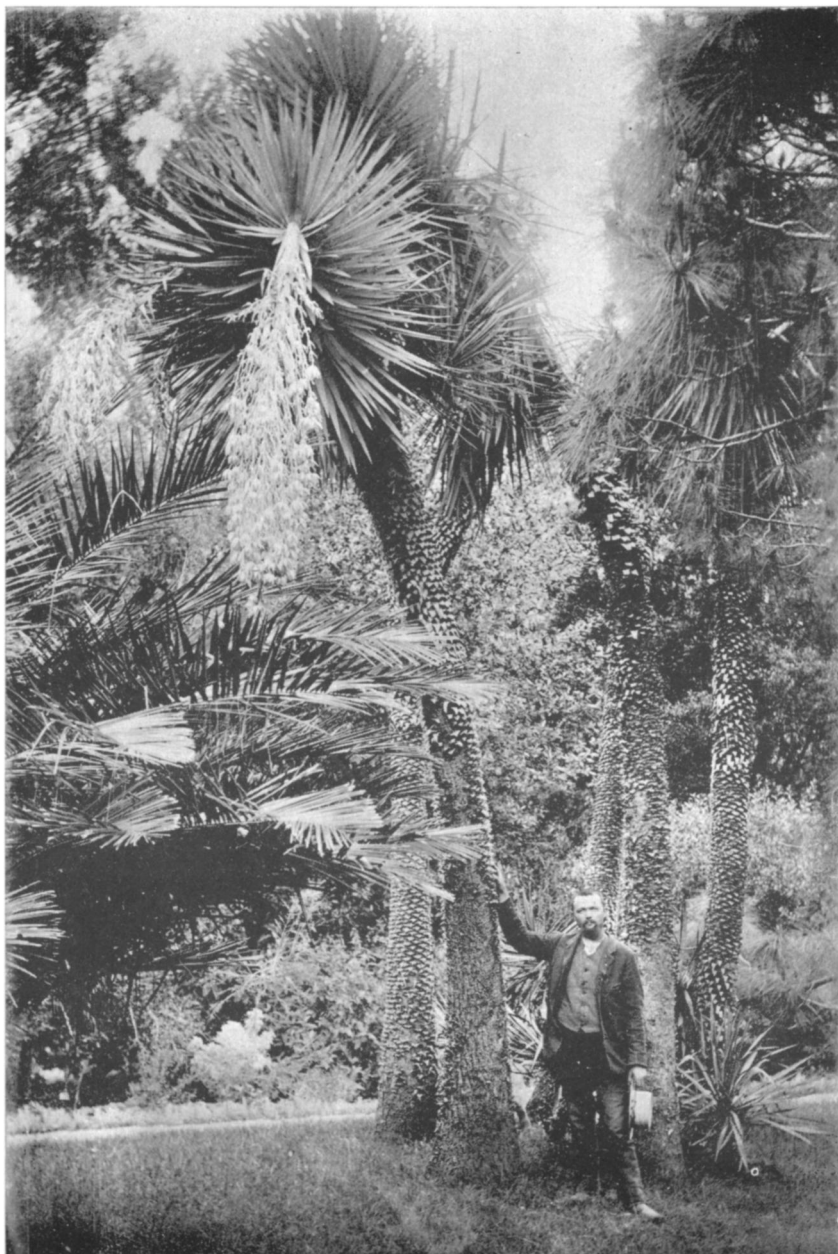
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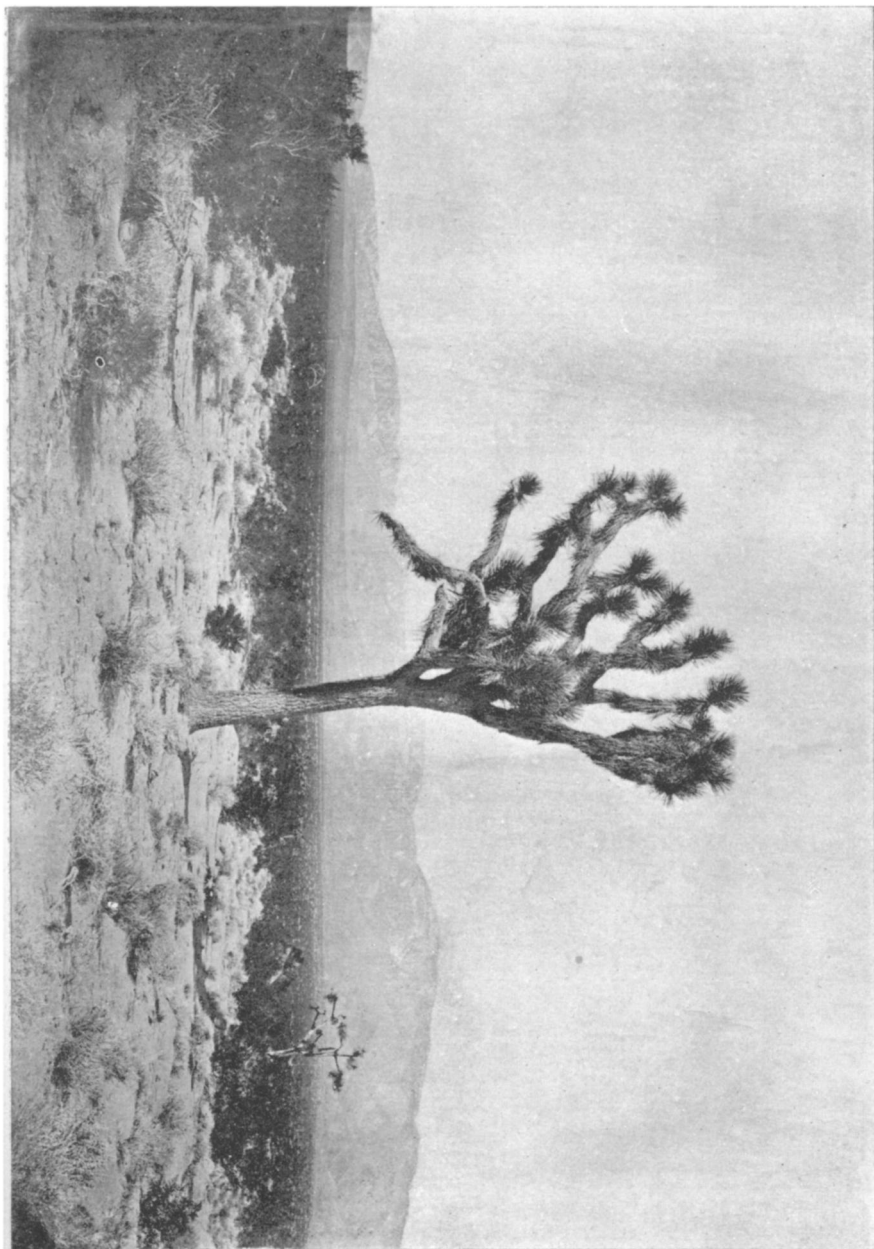
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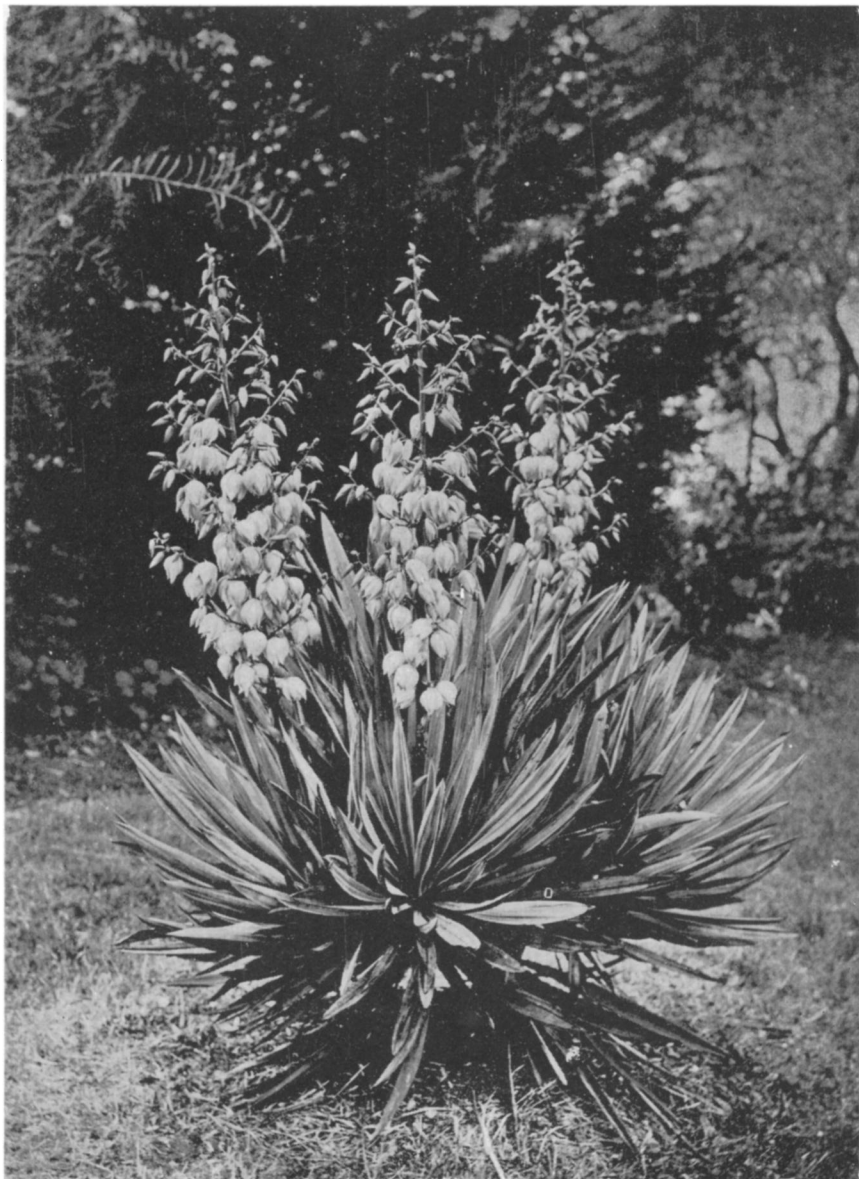
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YUCCA FILIFERA.



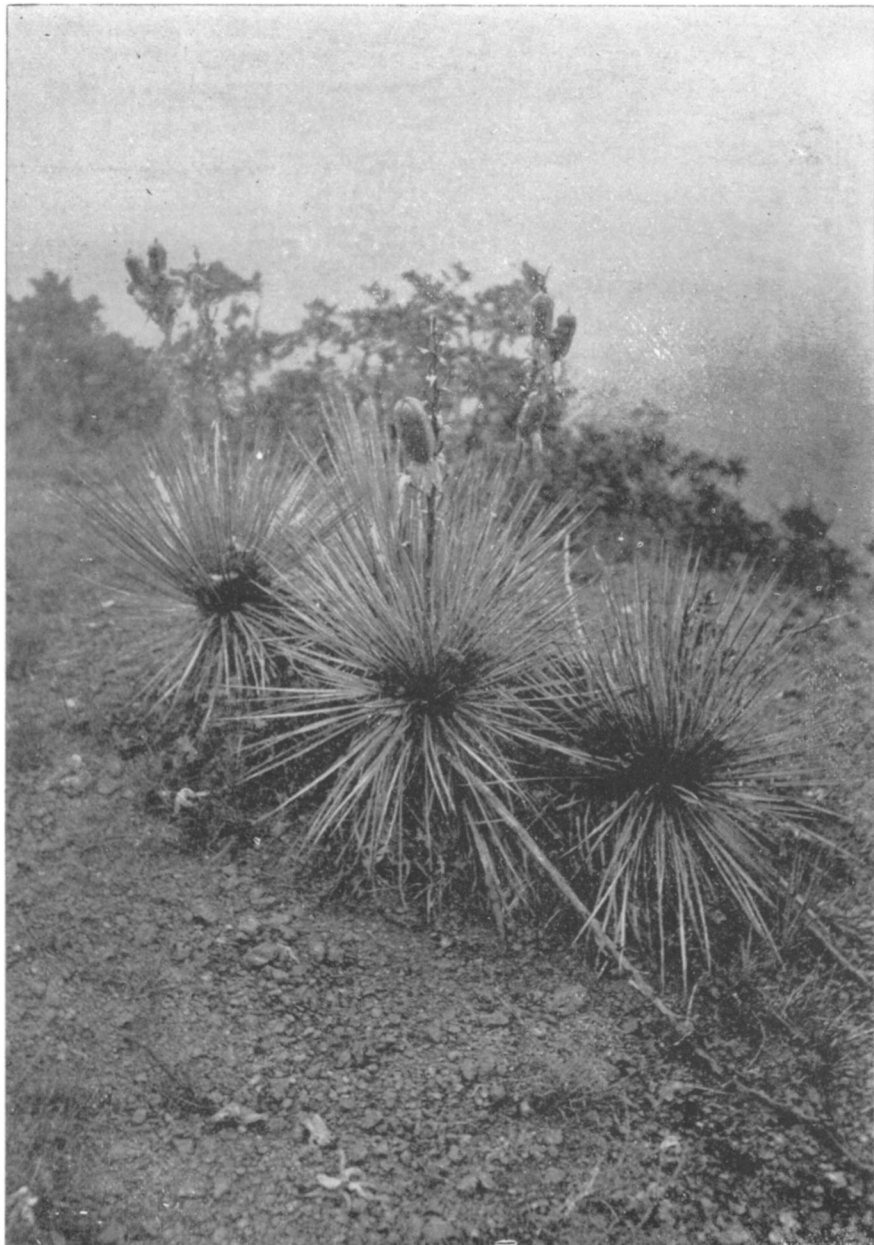
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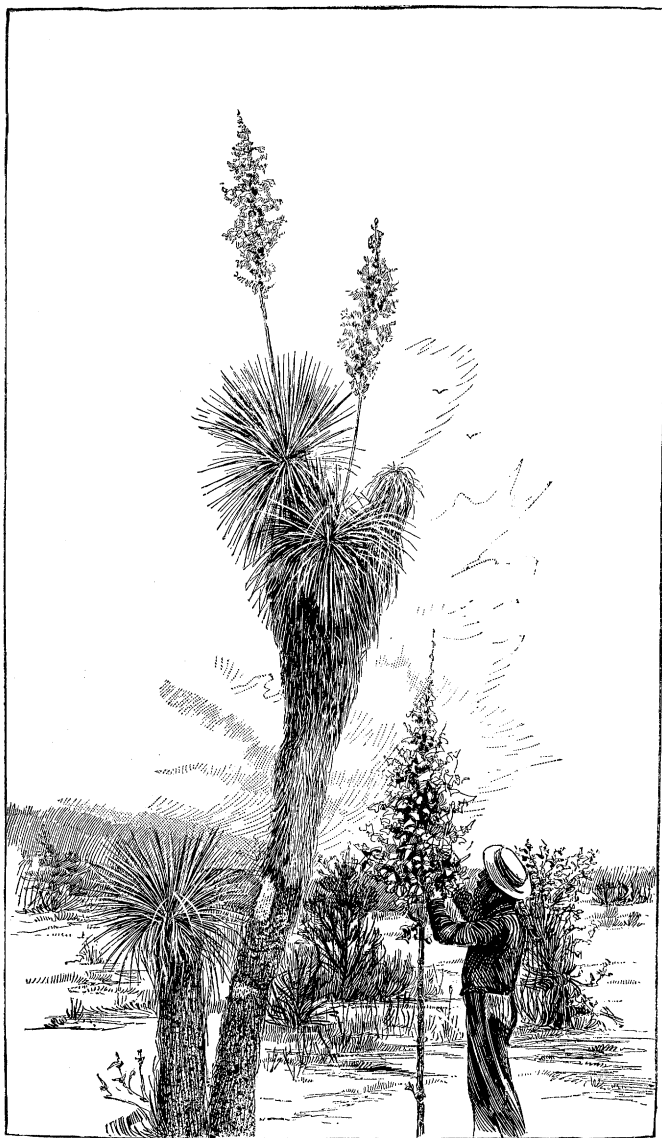
YUCCA GLORIOSA.



^a
YUCCA ALOIFOLIA (a) AND ^b
Y. GLORIOSA (b).



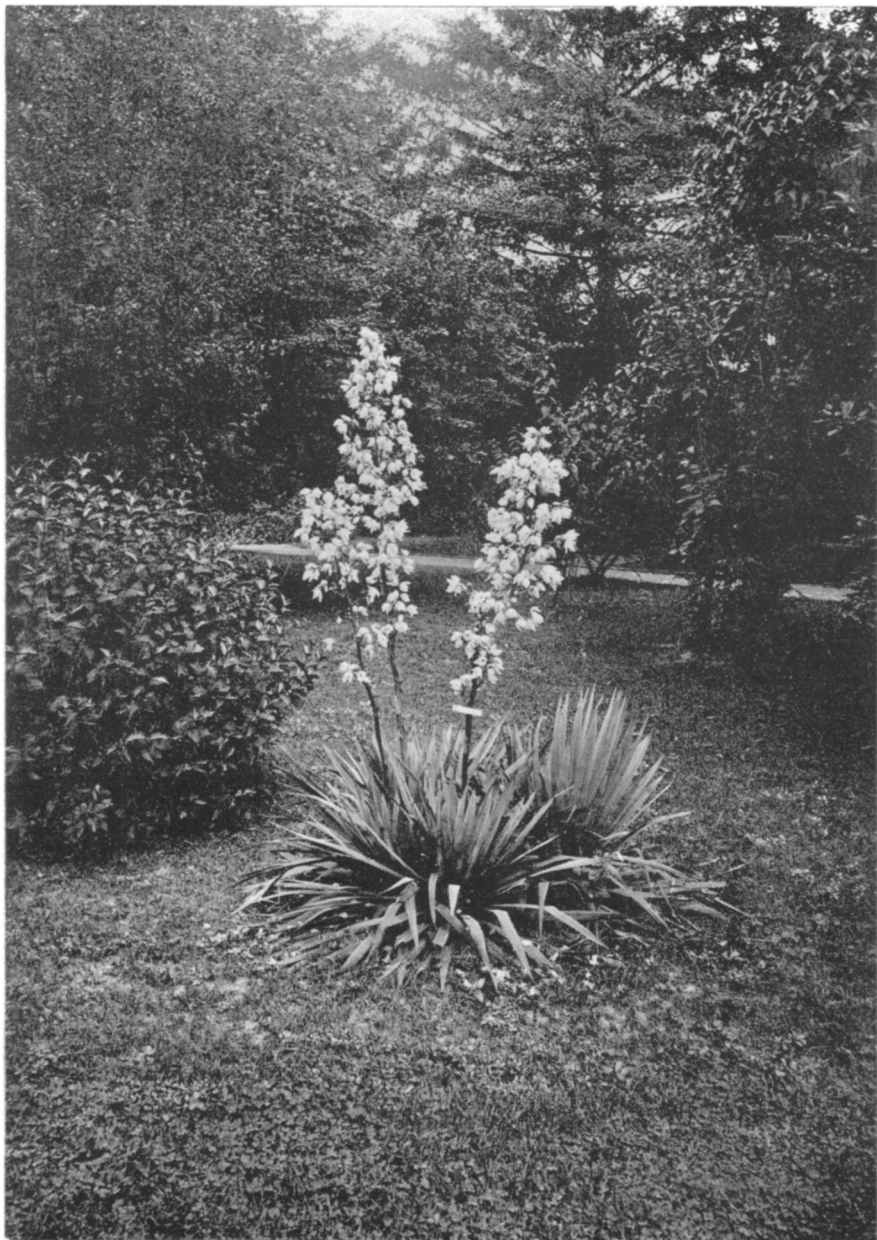
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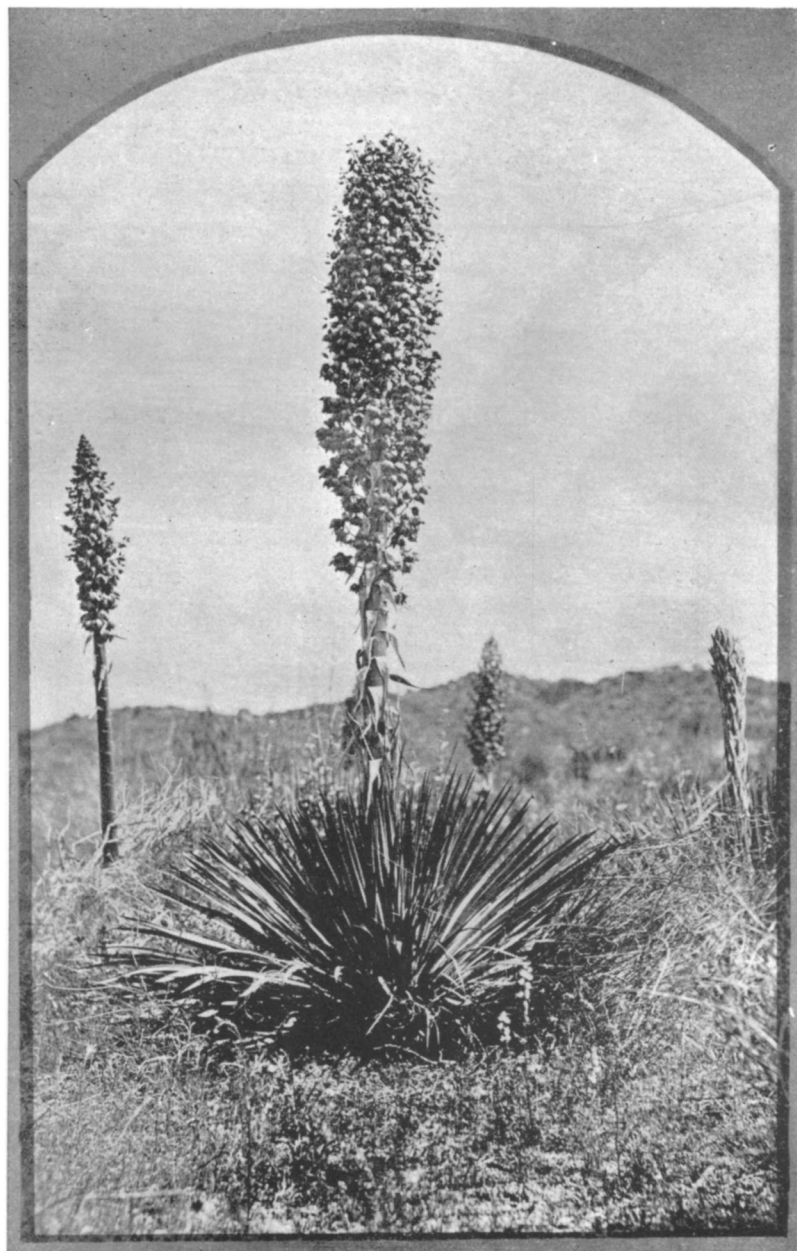
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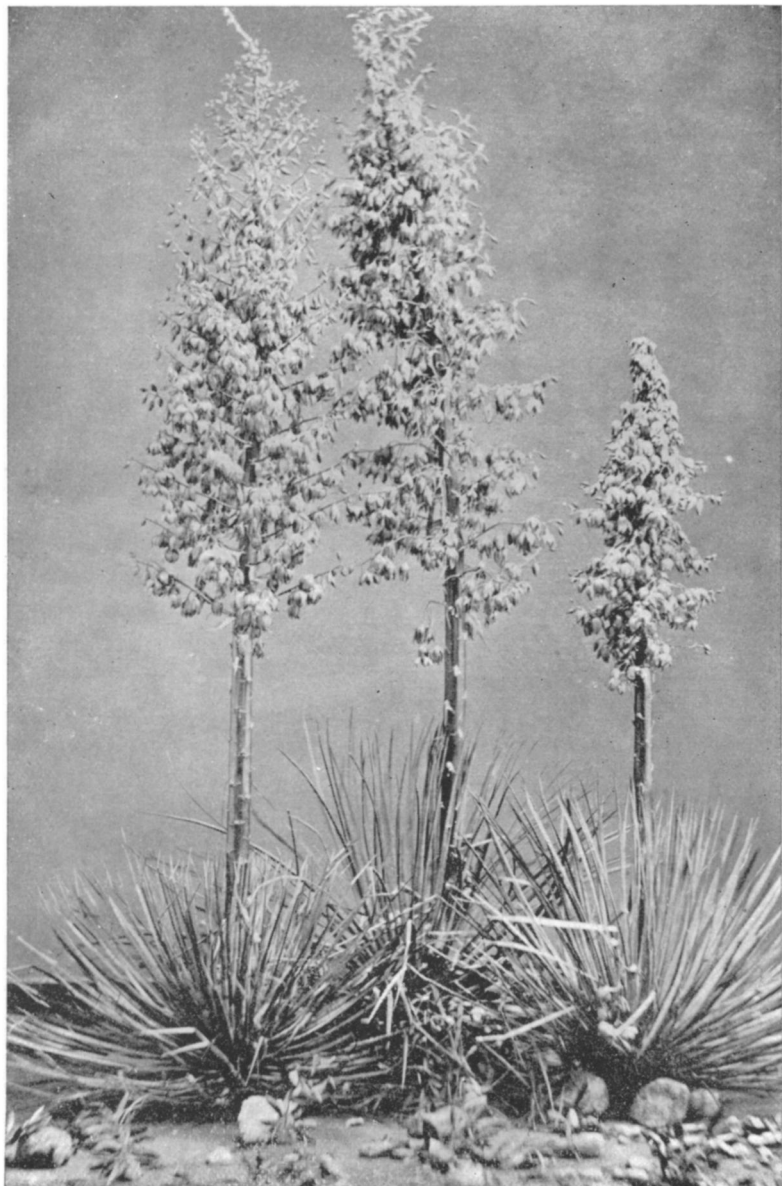
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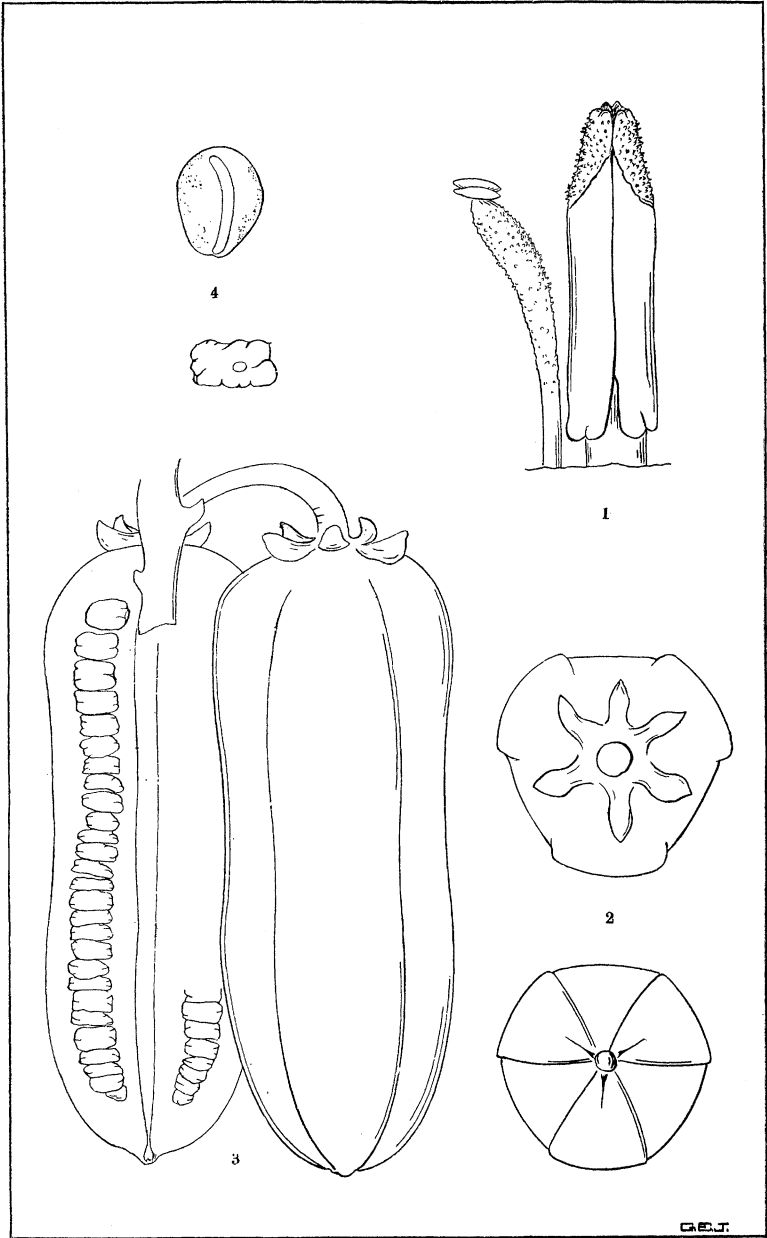
YUCCA FILAMENTOSA.



YUCCA WHIPPLEI.



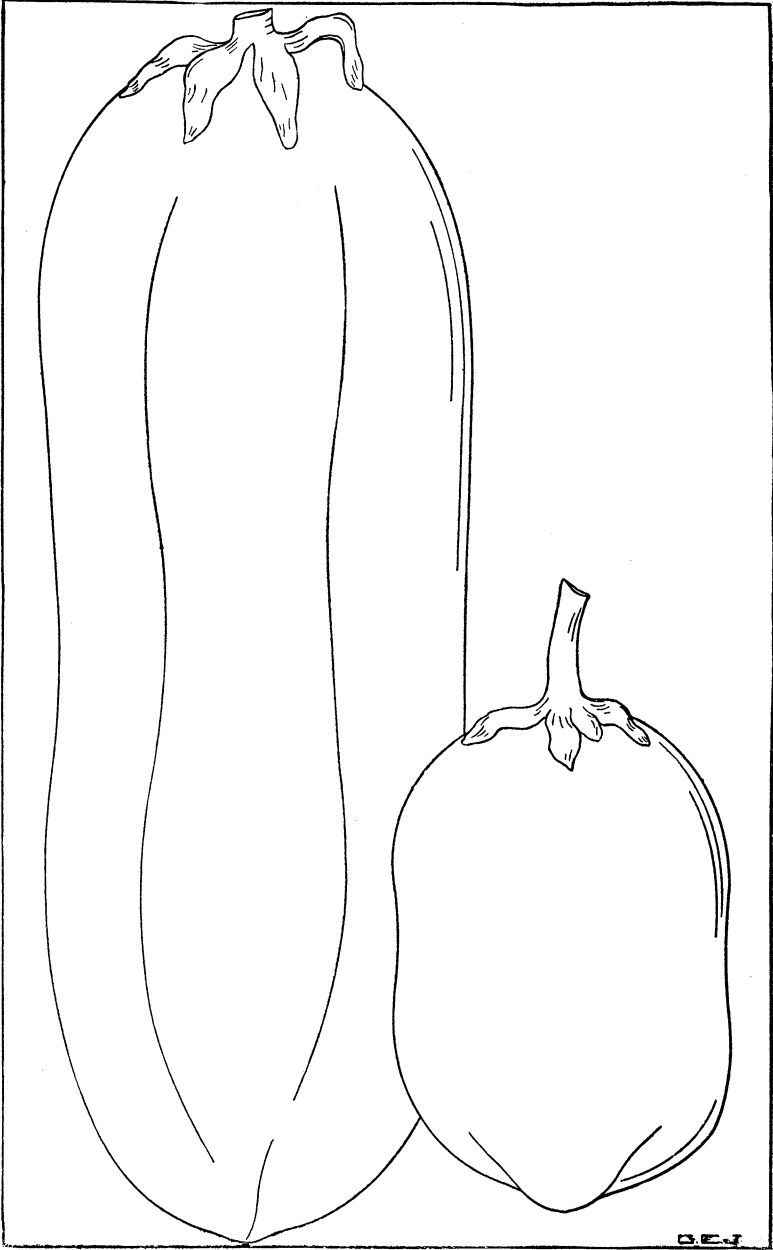
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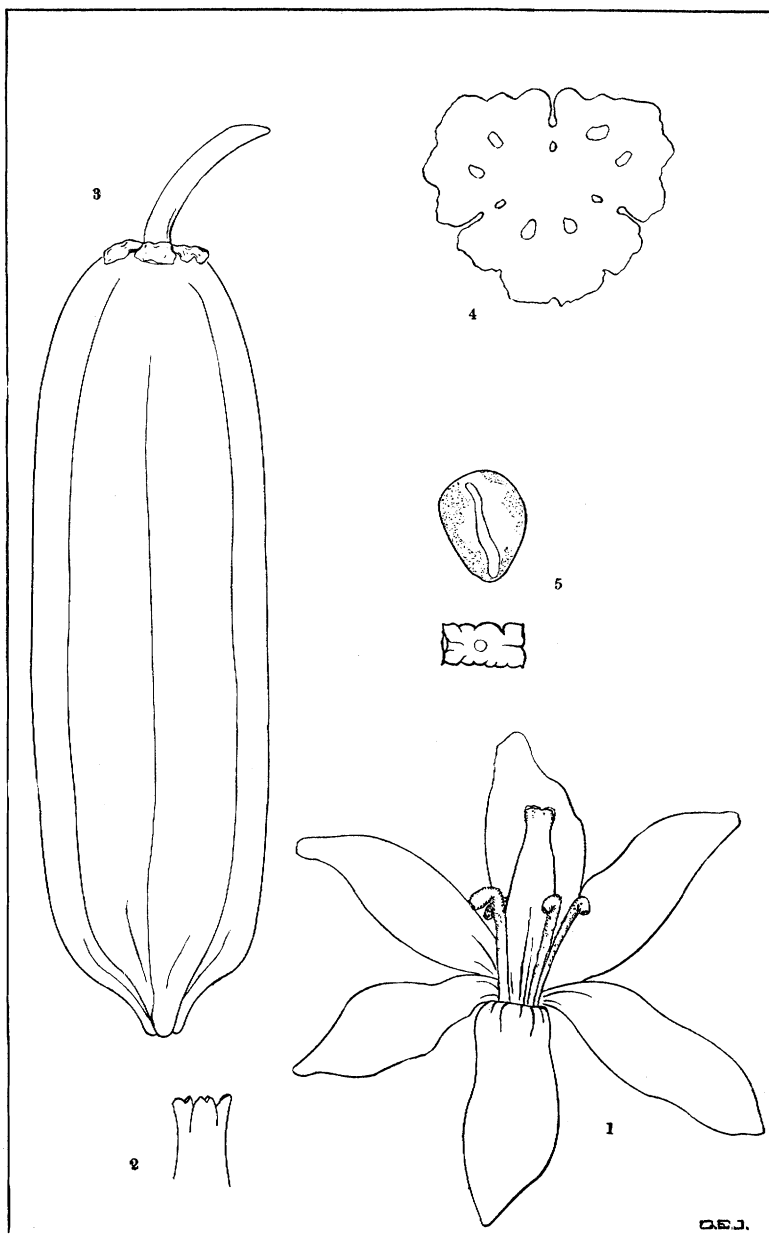
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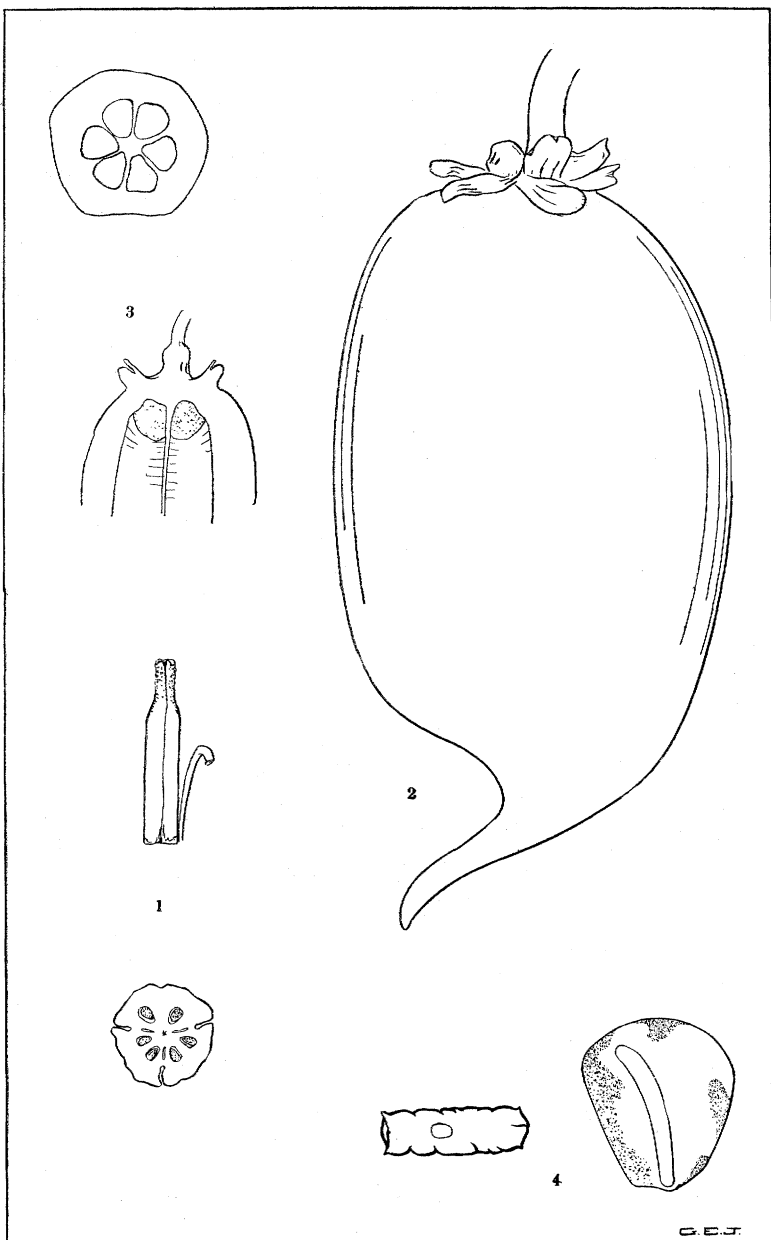
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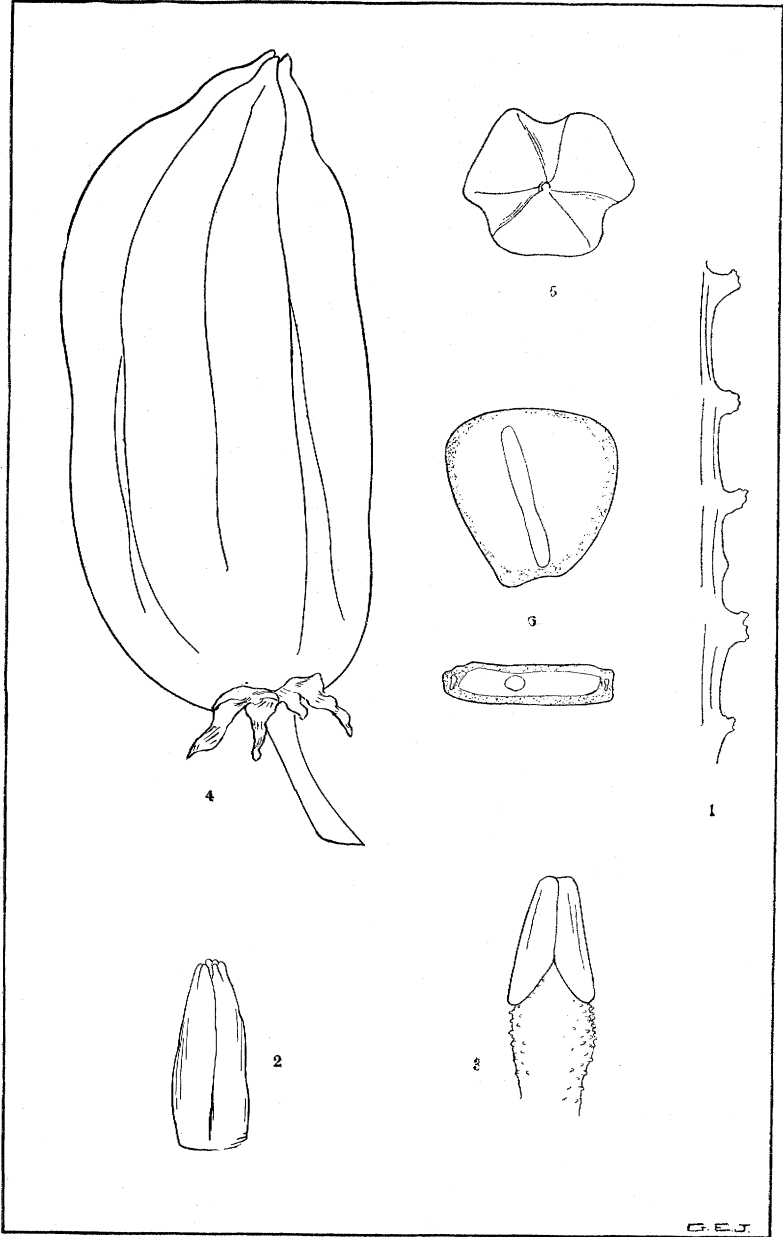
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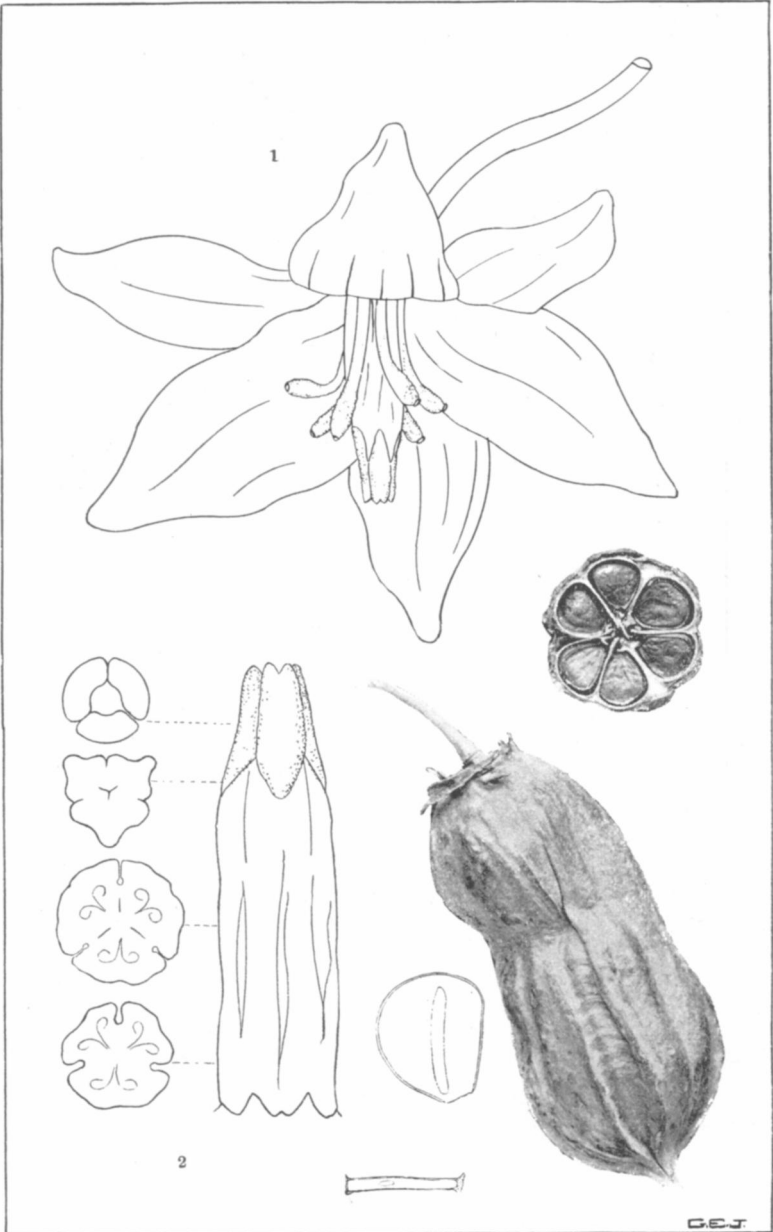
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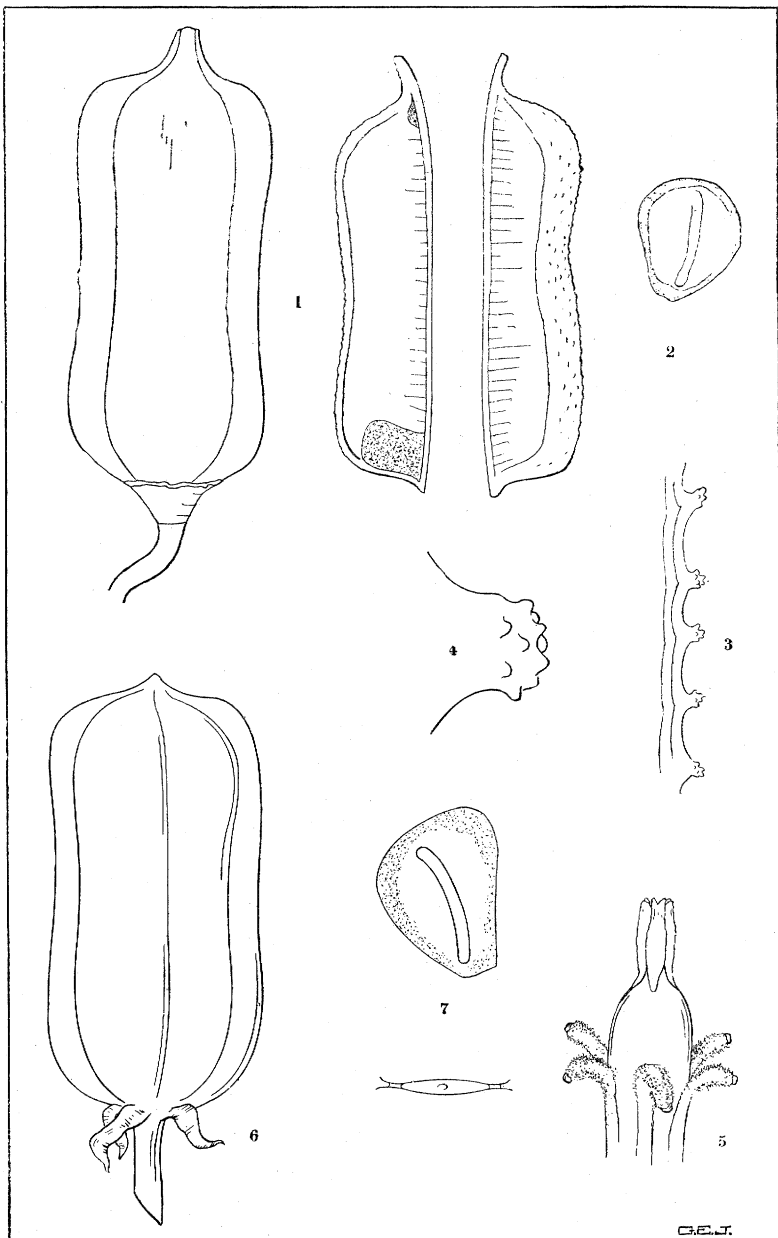
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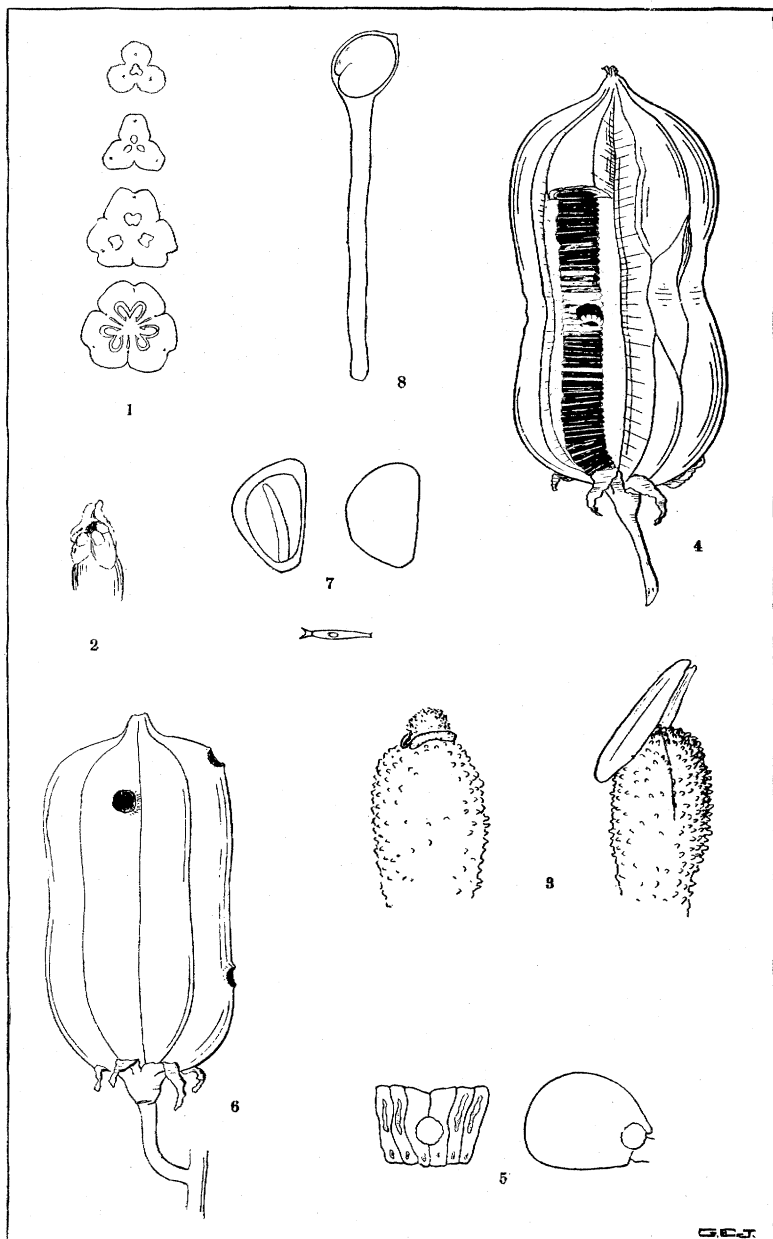
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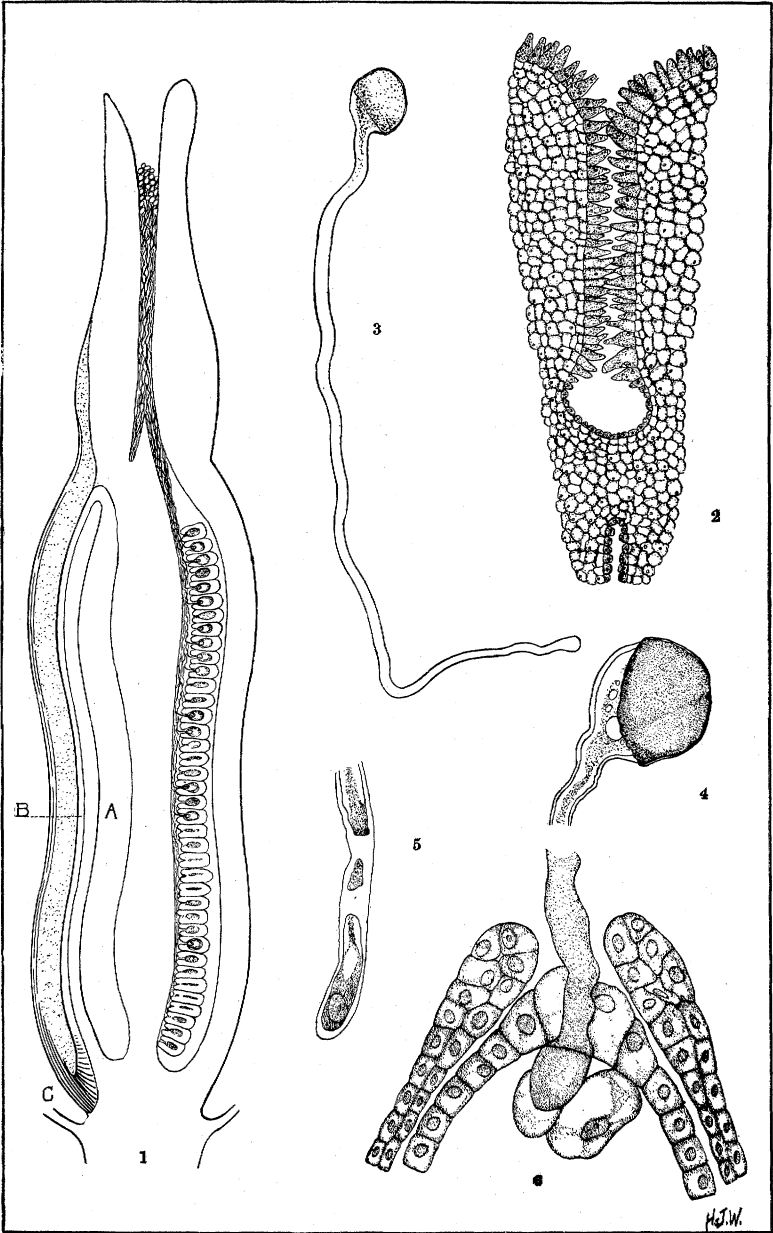
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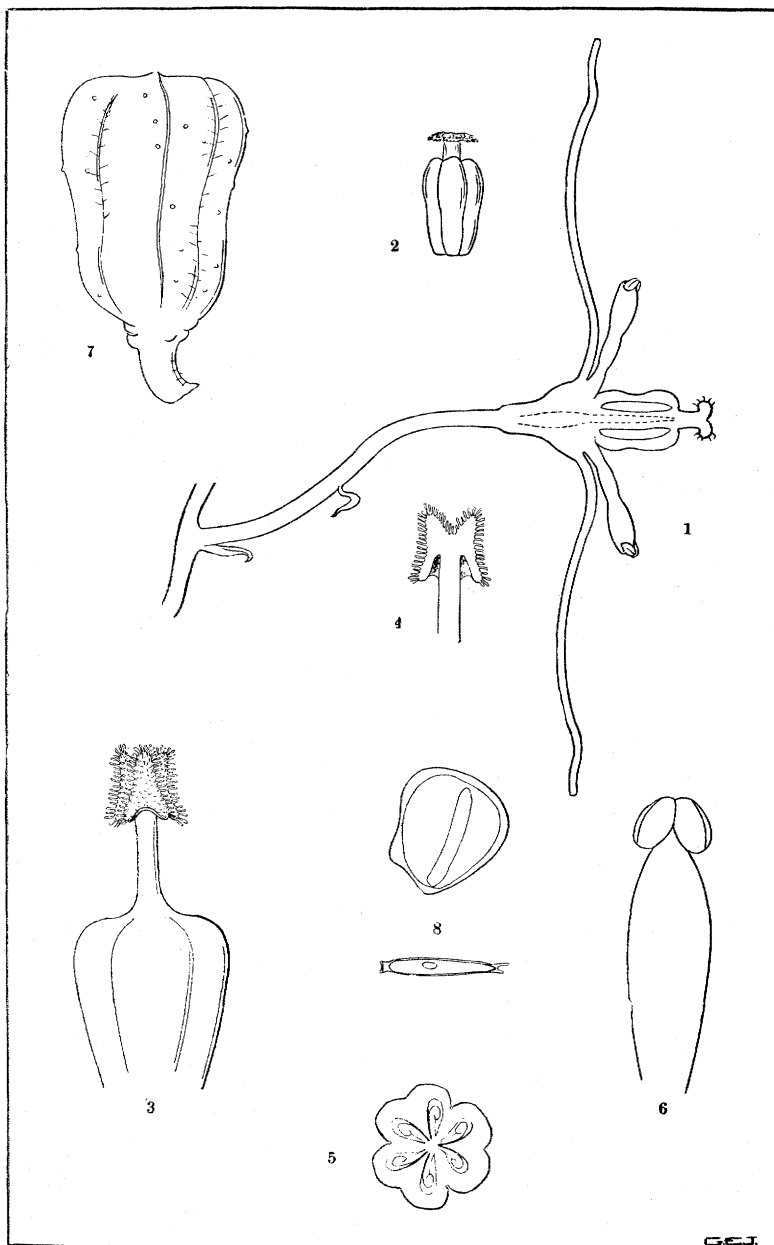
YUCCA RUPICOLA AND ANGUSTIFOLIA.



YUCCA FILAMENTOSA.



YUCCA FILAMENTOSA.



YUCCA WHIPPLEI.